

Introduction to Structural Geology (General review; Course focus)

Structural Geology

The study of geological structures in rocks.

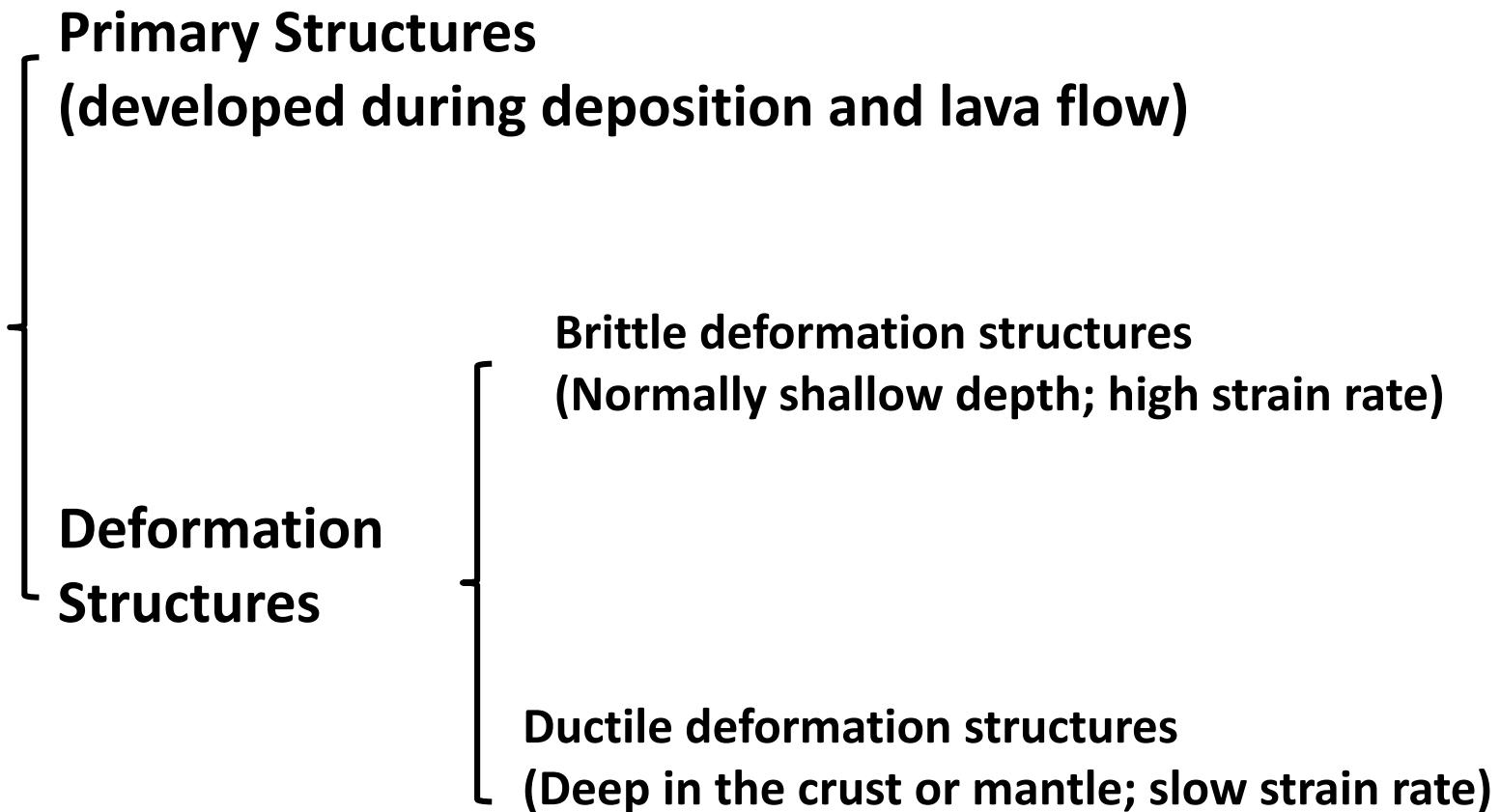
Structures (geometry), Processes of forming structures (motion; kinematics), and Cause (mechanical behavior).

Outline

- Geological structures
- Purpose and 3 levels of study
 - Geometrical study
 - Kinematic study (motion; Kinematics)
 - Dynamic study (Cause; Mechanic behavior)
- Kinematic study based on geometry
- Structures in tectonic setting

Geological structures

Geological Structures



Some Primary Structures



Figure 5.7d

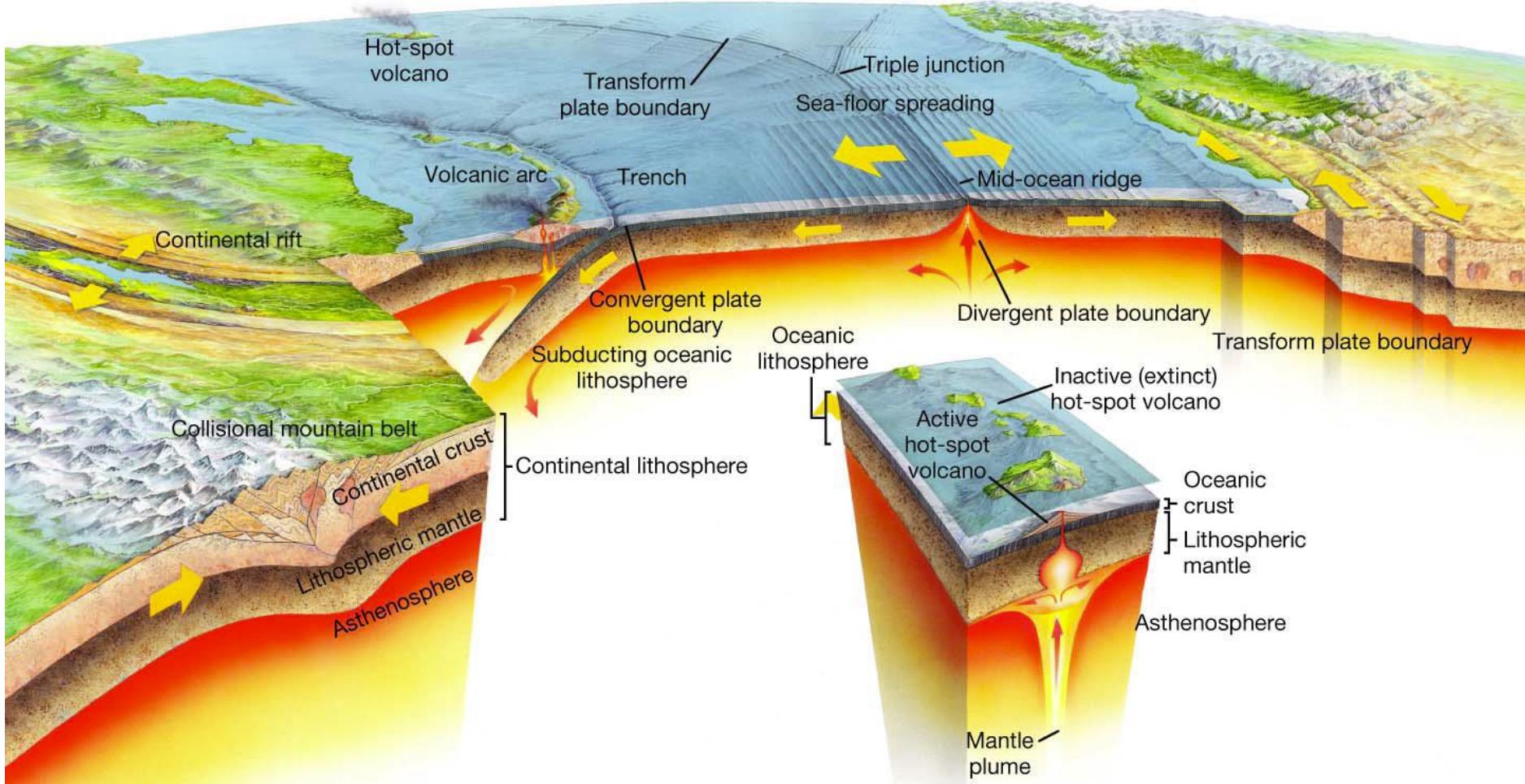
From a geology book

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Deformation structures



The Theory of Plate Tectonics

Heat and gravity drive plate tectonics

Plate tectonics leads plate boundaries and interiors to deform to produce structures [fingerprint of deformation]

Brittle deformation structure



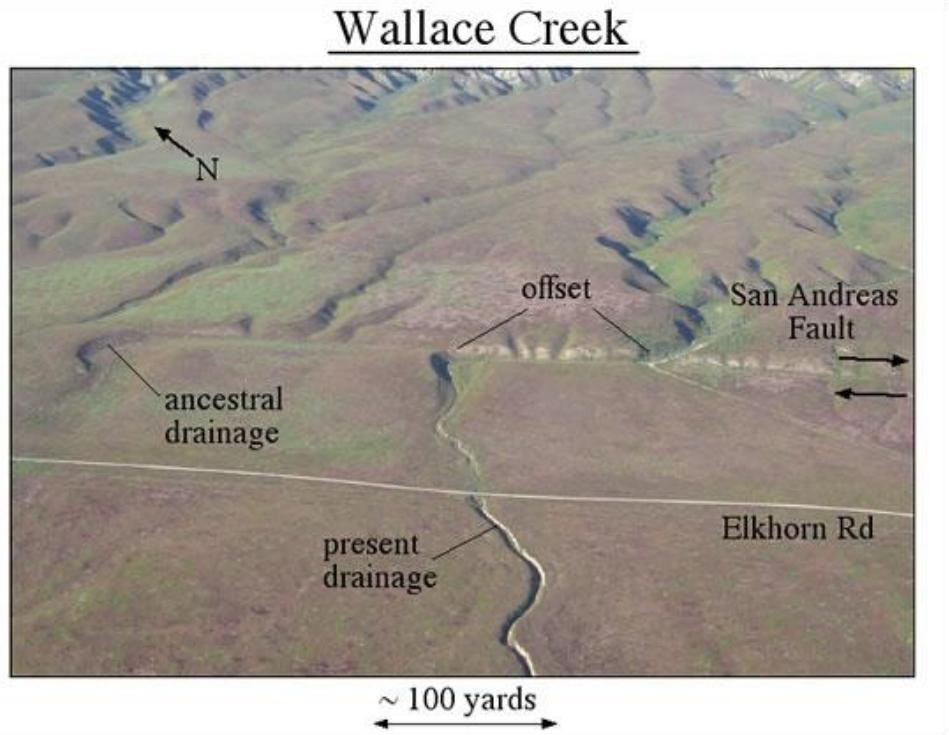
Courtesy of Jiang



Zhangjiajie, Hunan, China
Photo by Softdiyer

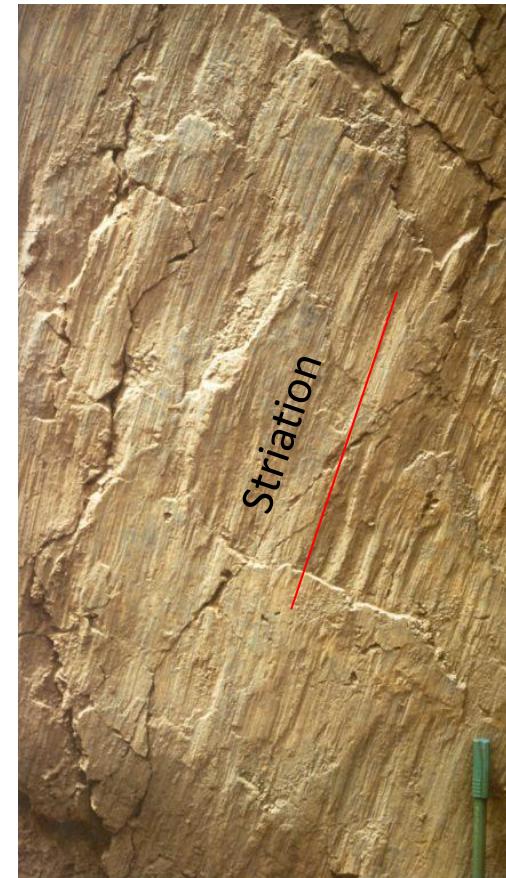
Brittle deformation structure: fault

Wallace Creek



Aerial photo taken by David Lynch

<http://geology.com/articles/san-andreas-fault.shtml>



<http://blog.sciencenet.cn/blog-51597-550821.html>

Striation on fault plane

Brittle deformation structures



In Sudbury

Ductile deformation: rock flows

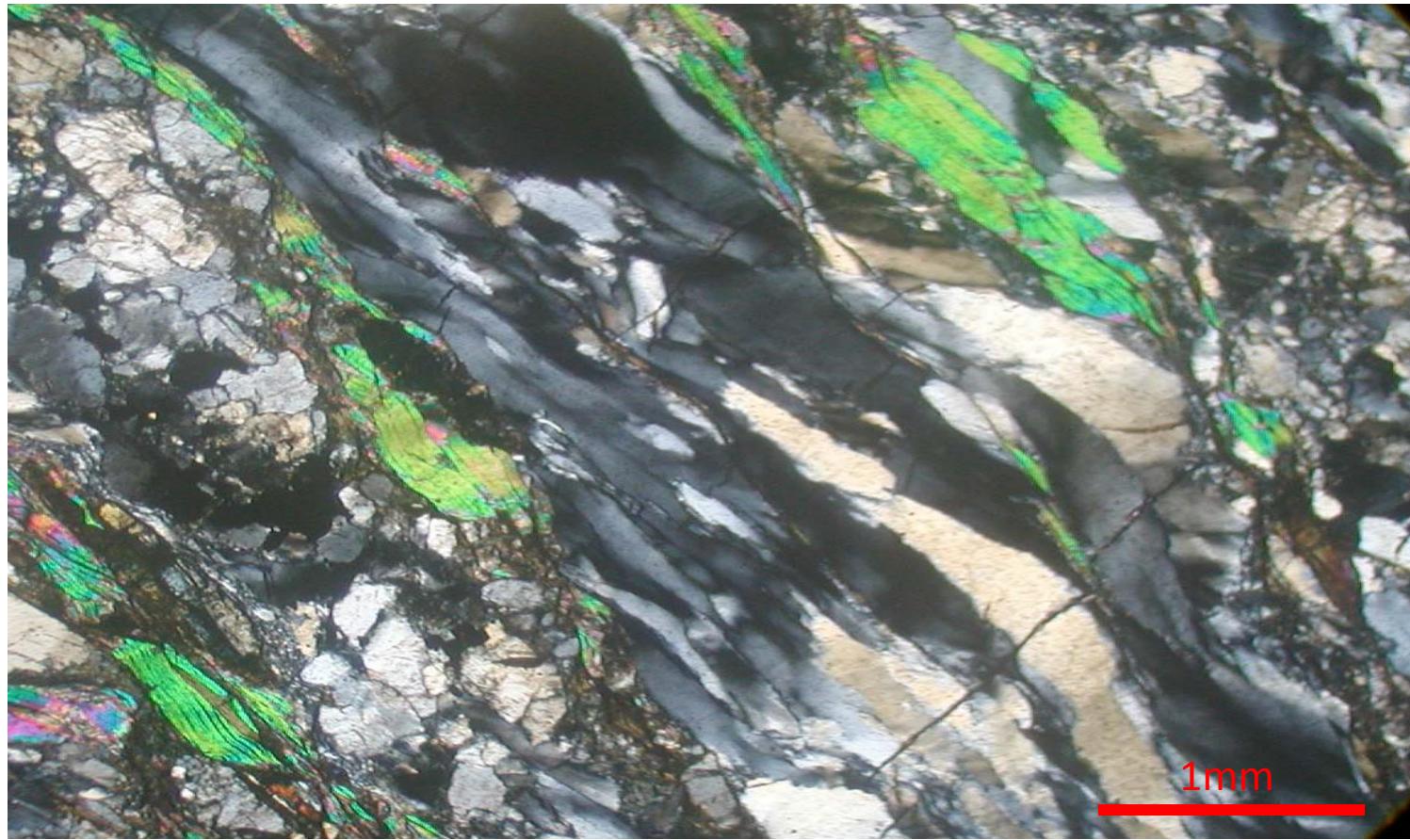


Silicone putty

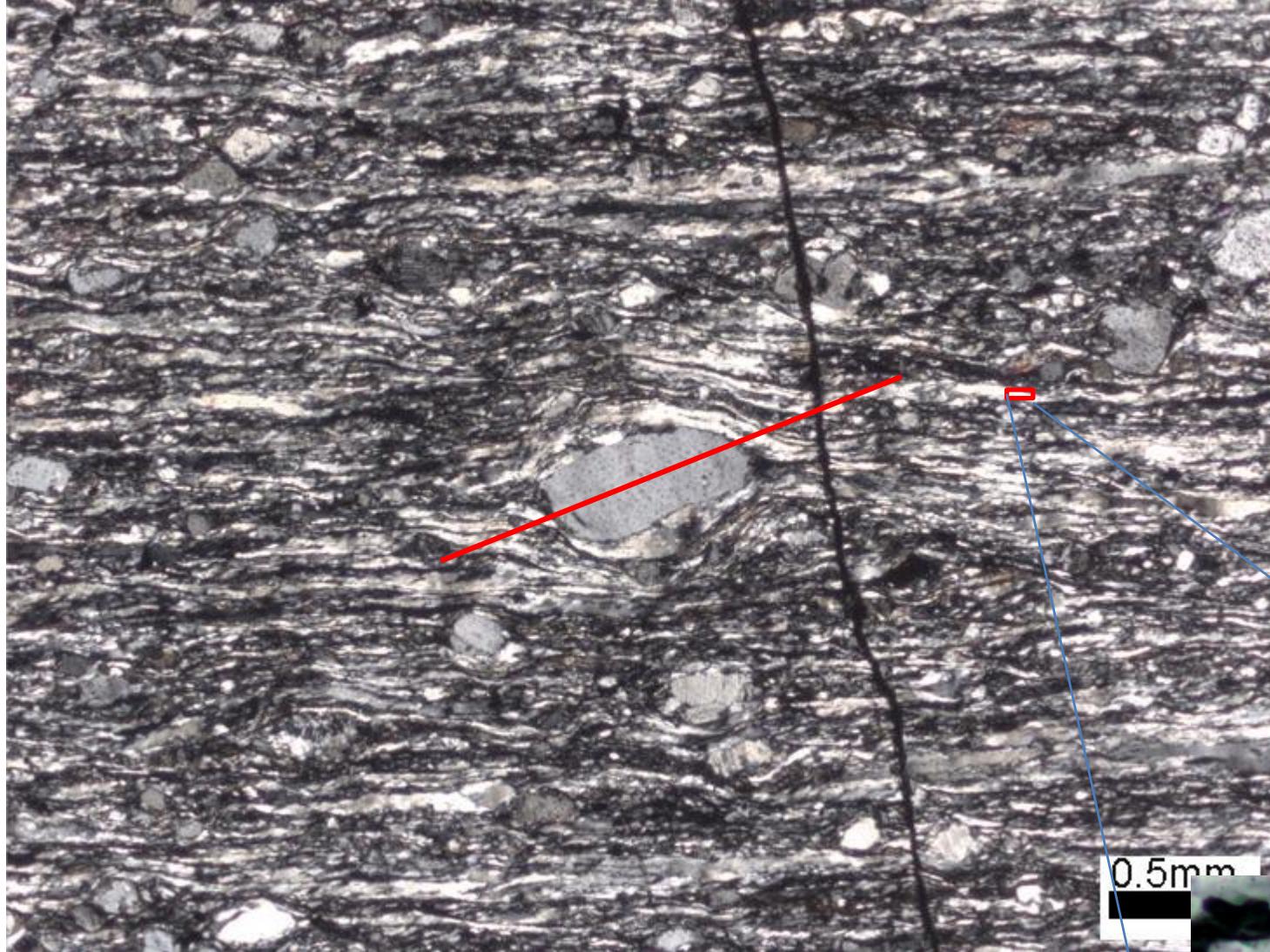


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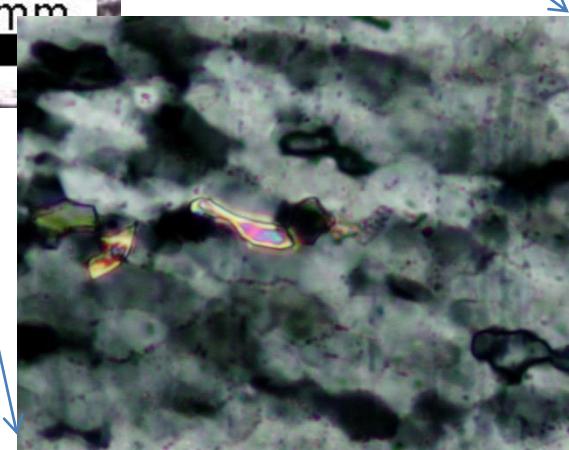
Ductile deformation: Quartz ribbon



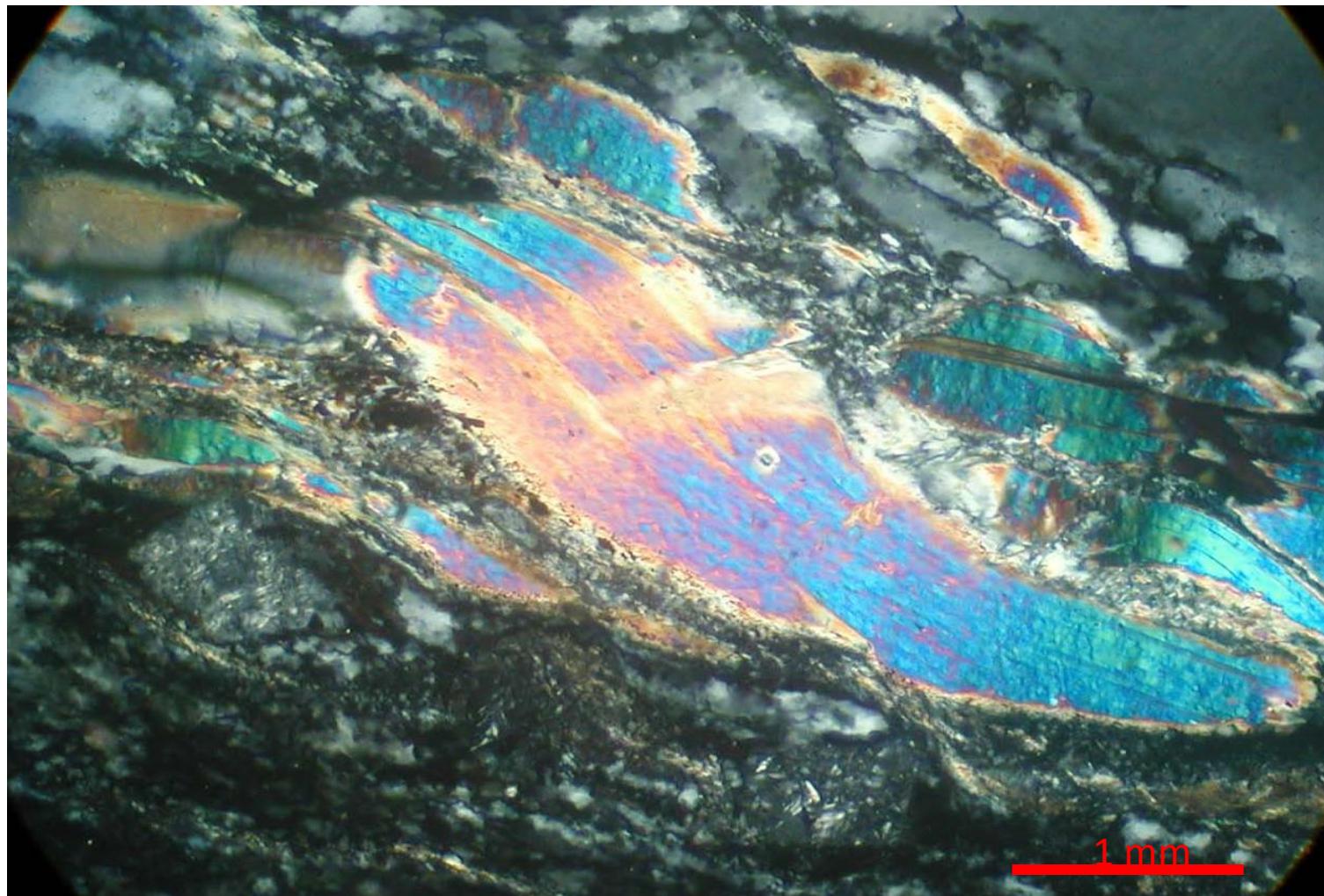
Grenville Front near Sudbury
Under microscope: quartz is stretched



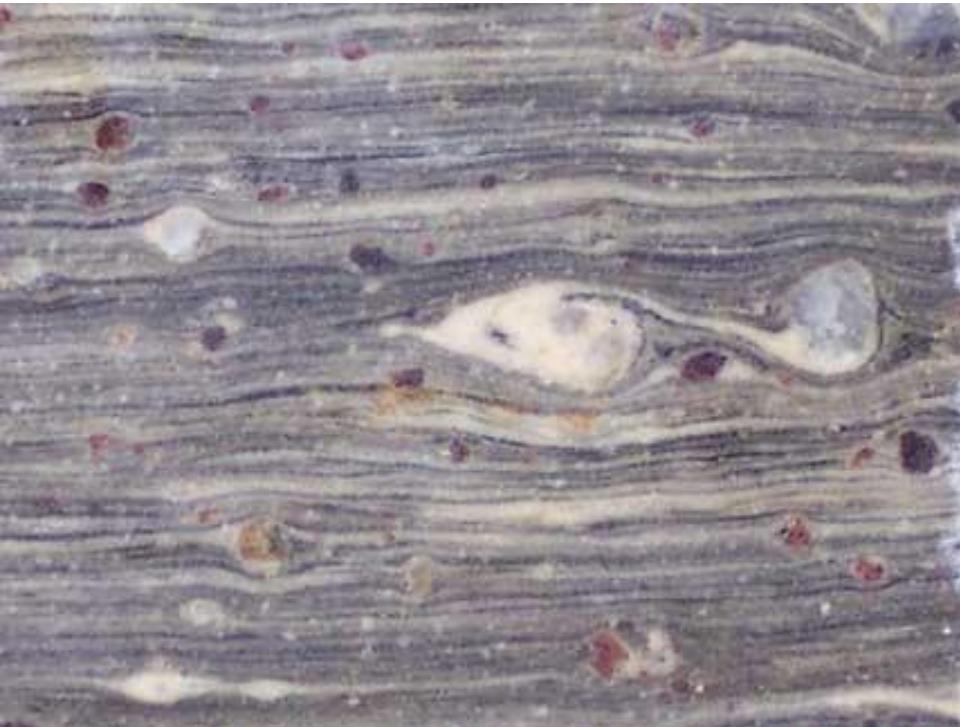
0.5mm



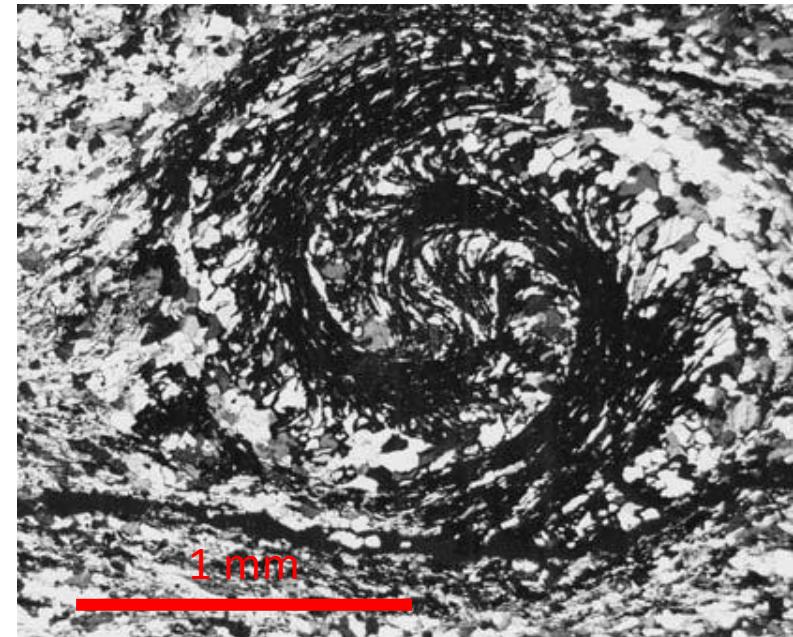
Ductile deformation: Mica fish



Snowball garnet

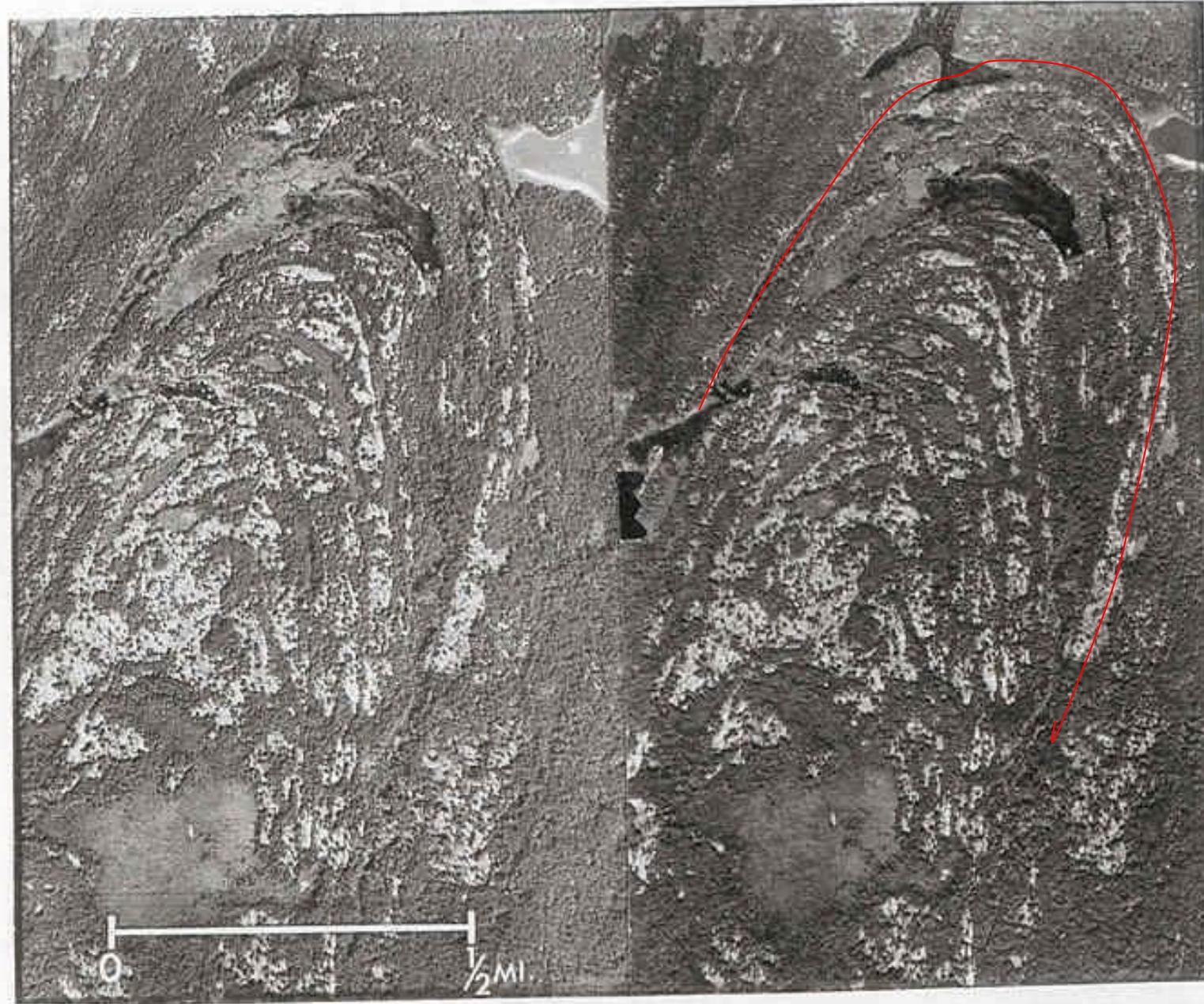


From internet



From internet

Spiral inclusion trial: Does the garnet rotate?
Clockwise rotation or anticlockwise rotation?
Why does it rotate?



Southeast of Haultain, Ontario. (From Gartner, 2004)



Ductile deformation: Folds



Folds near Sudbury, Ontario, in the Grenville geological province.

Ductile deformation: Folds



Near Sudbury, in the Grenville geological province

Ductile deformation: Transposition Foliation



Near Sudbury in the Grenville geological province

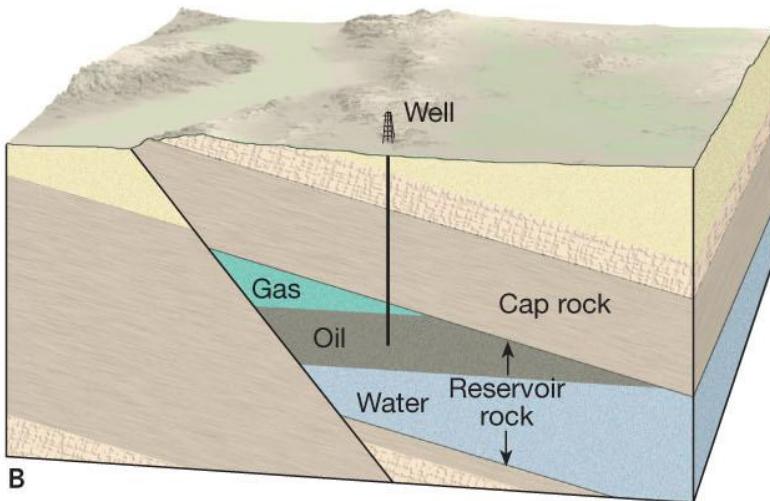
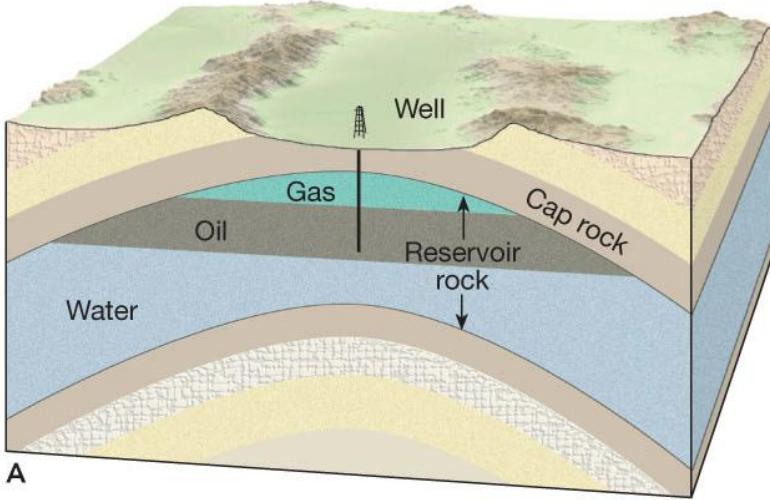
Purposes of Structural Study

- To understand Earth history (the tectonic history of a region)
- To understand the mechanical properties of the crust at the time of deformation
- To serve some more practical purposes such as mining, exploration, evaluation of slope stability...

3 Levels of Structural Study

- Geometrical: descriptive; what is there?
Orientation, Size, Geometrical characteristics,
Relationship between structures
- Kinematic: Evolution of the geometry.
Movement involved in producing the
structures.
- Dynamic: The cause of the movement,
application of mechanical principles.

Why is geometrical study important?



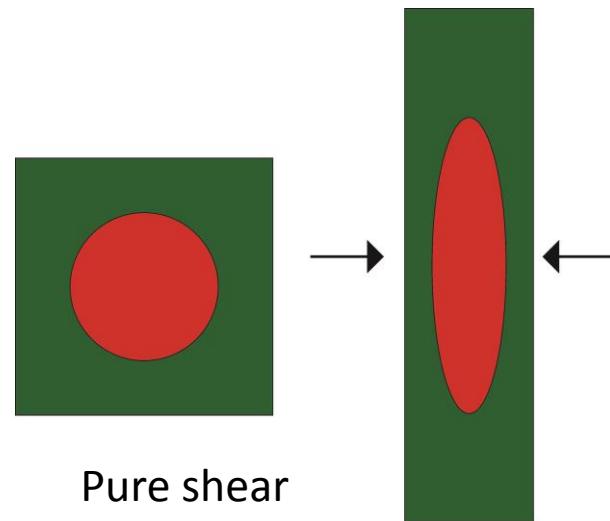
- Resources exploration and mining
- Infrastructure construction
- Management of environment, mitigation of nature hazards
- Necessary for kinematic study and dynamic study

Kinematic study: Deformation process

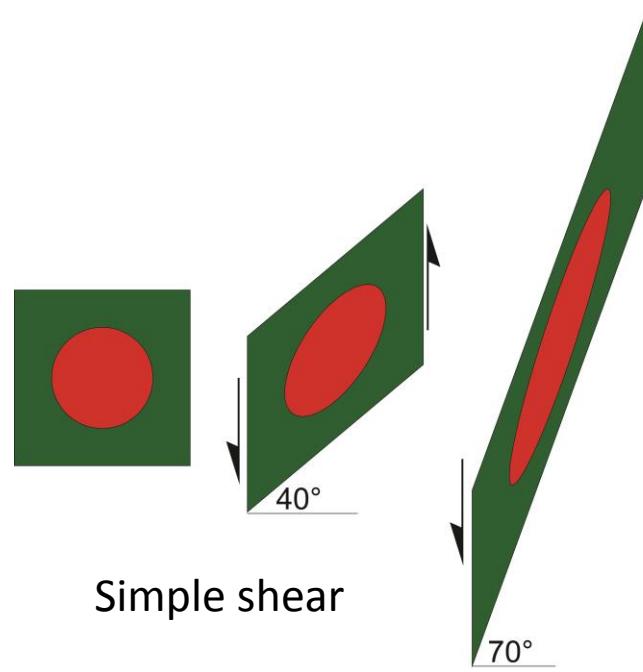


<http://blog.sciencecn.net/blog-51597-550821.html>

Squeeze from two sides toward center?



Pure shear

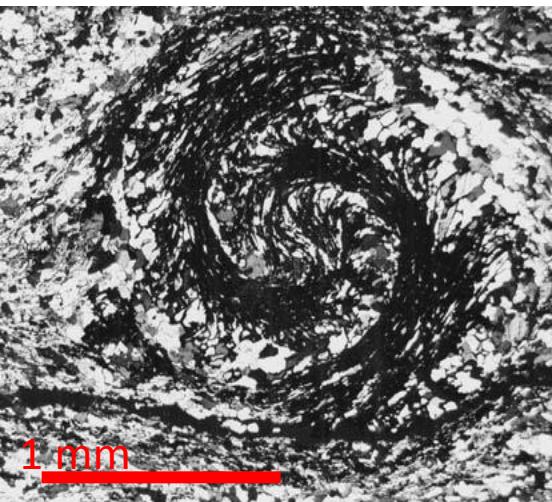


Simple shear

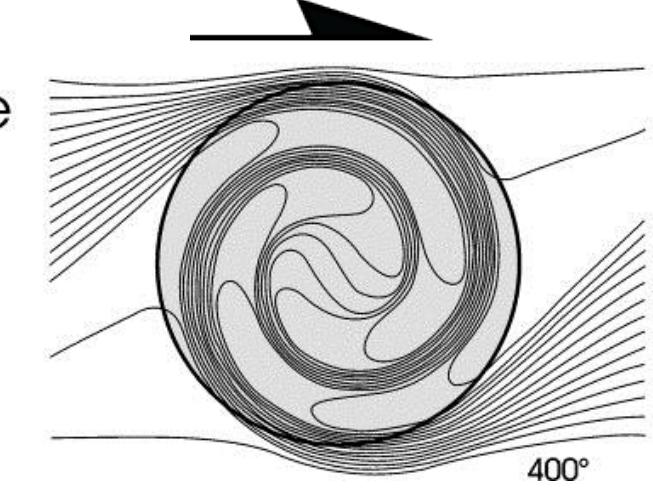
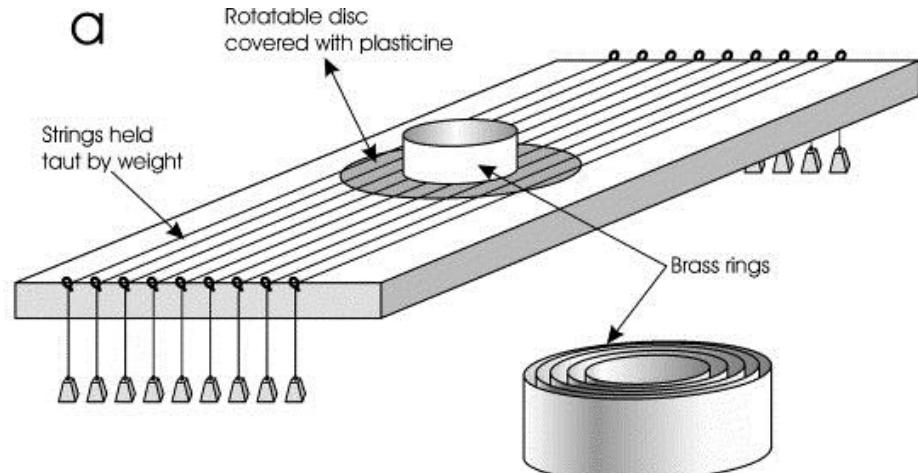
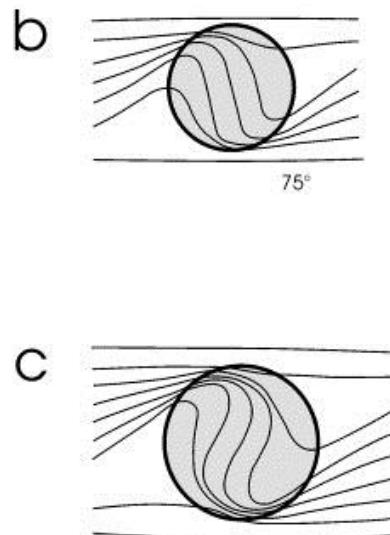
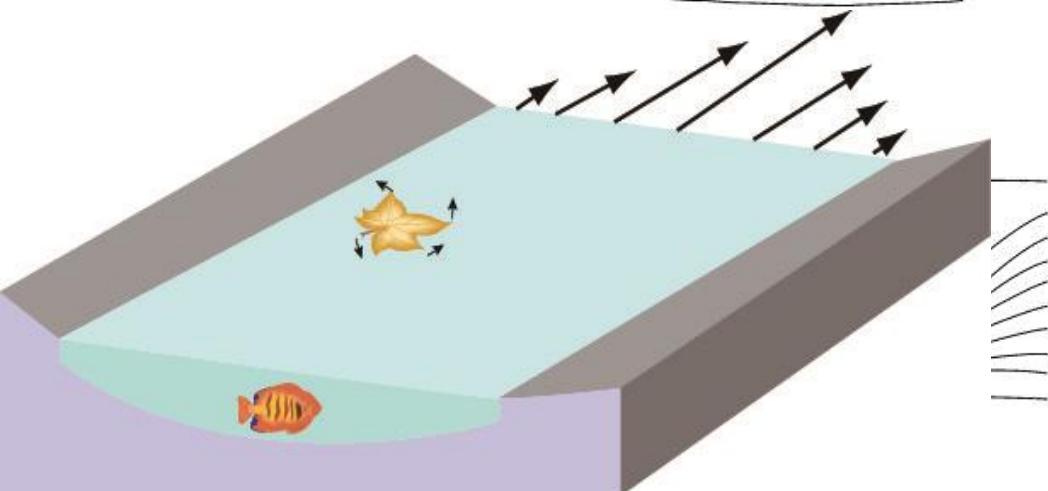
Deformation process



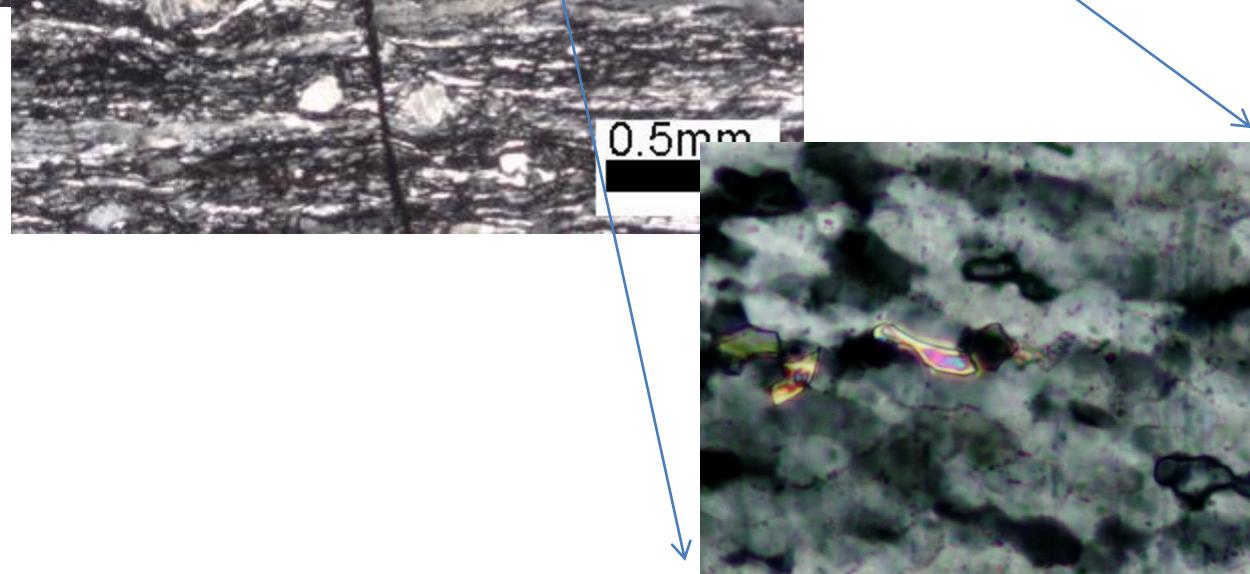
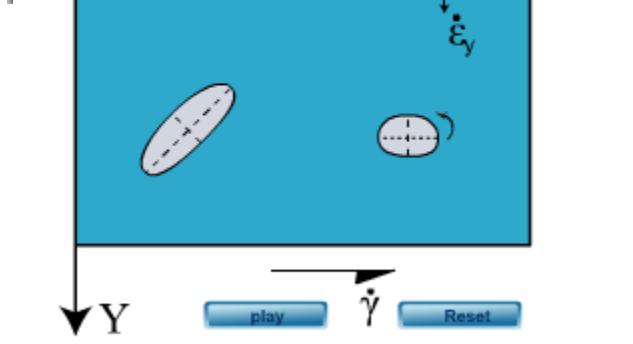
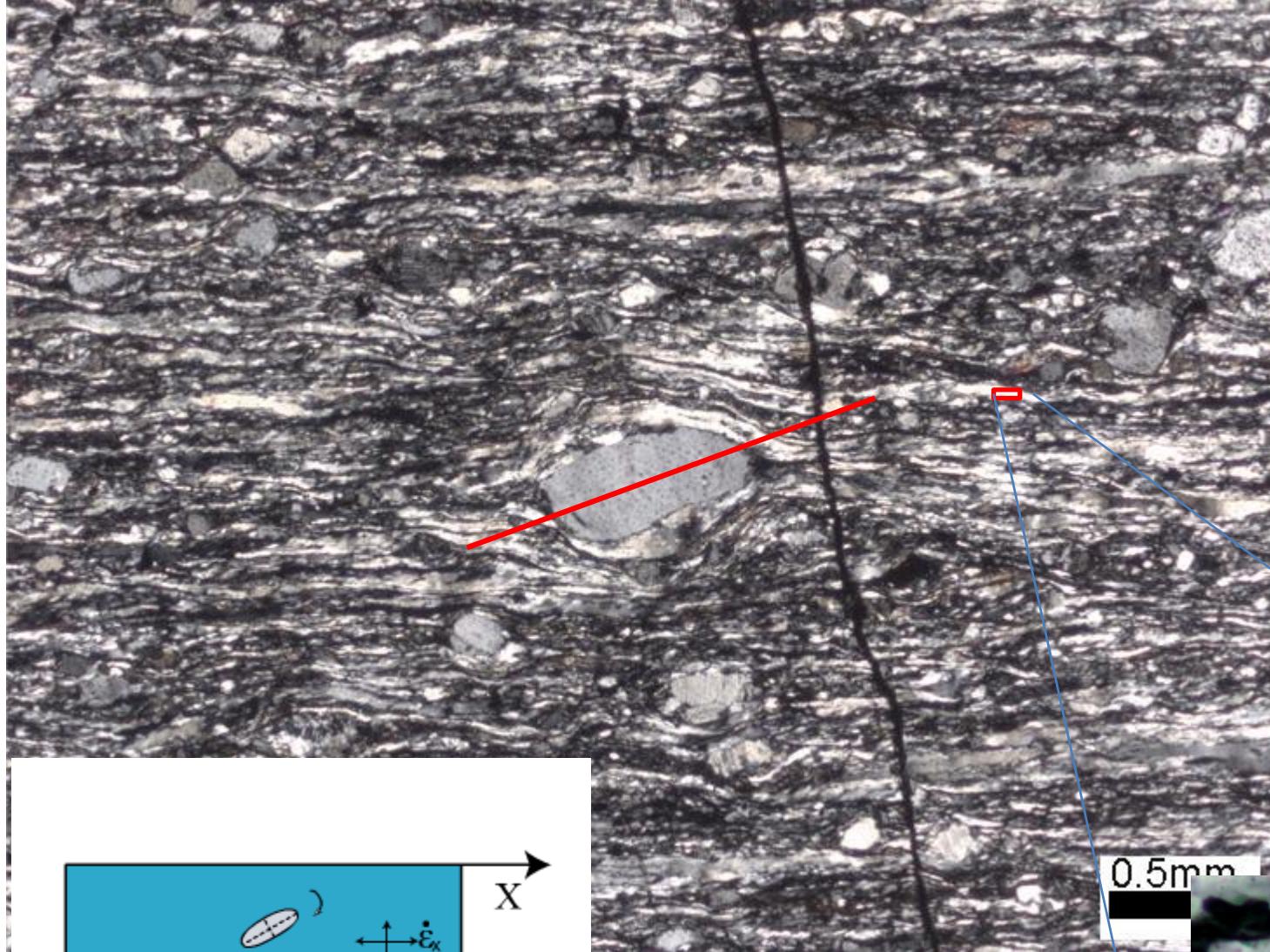
Snowball garnet

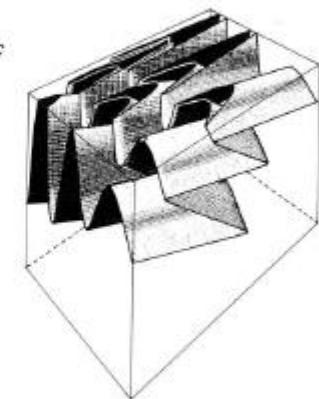
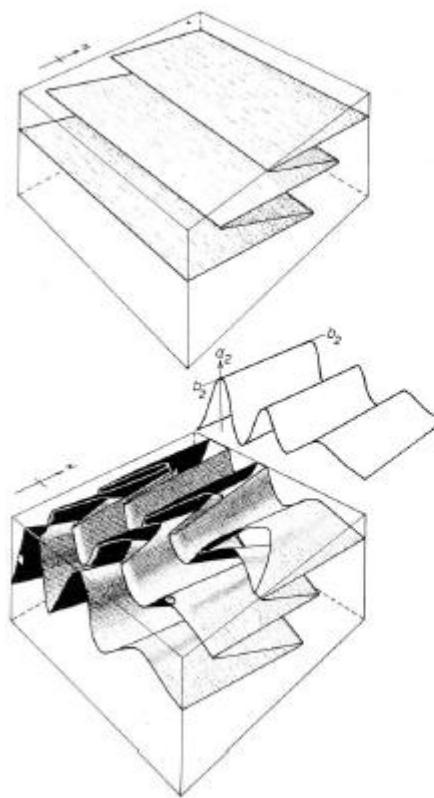
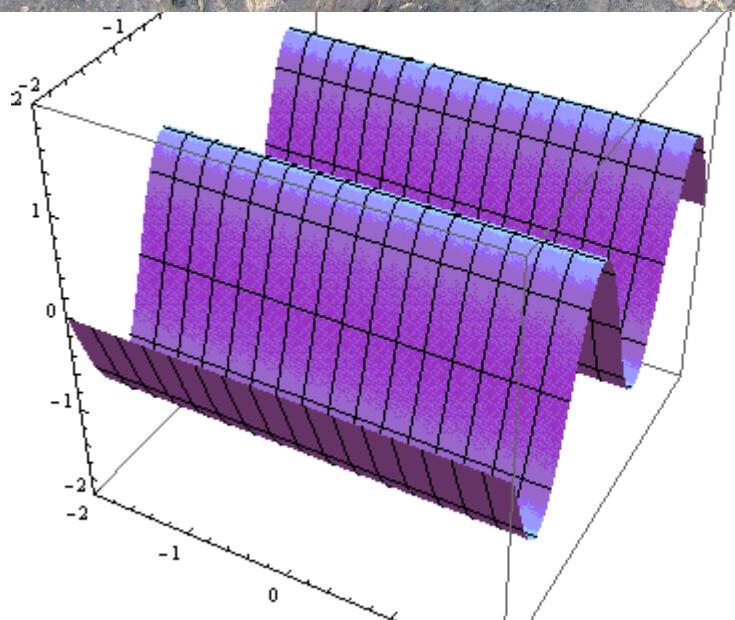


From internet

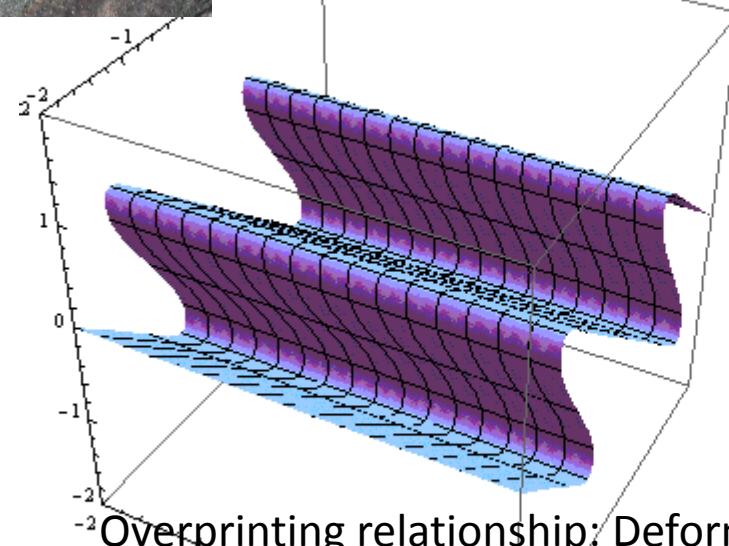
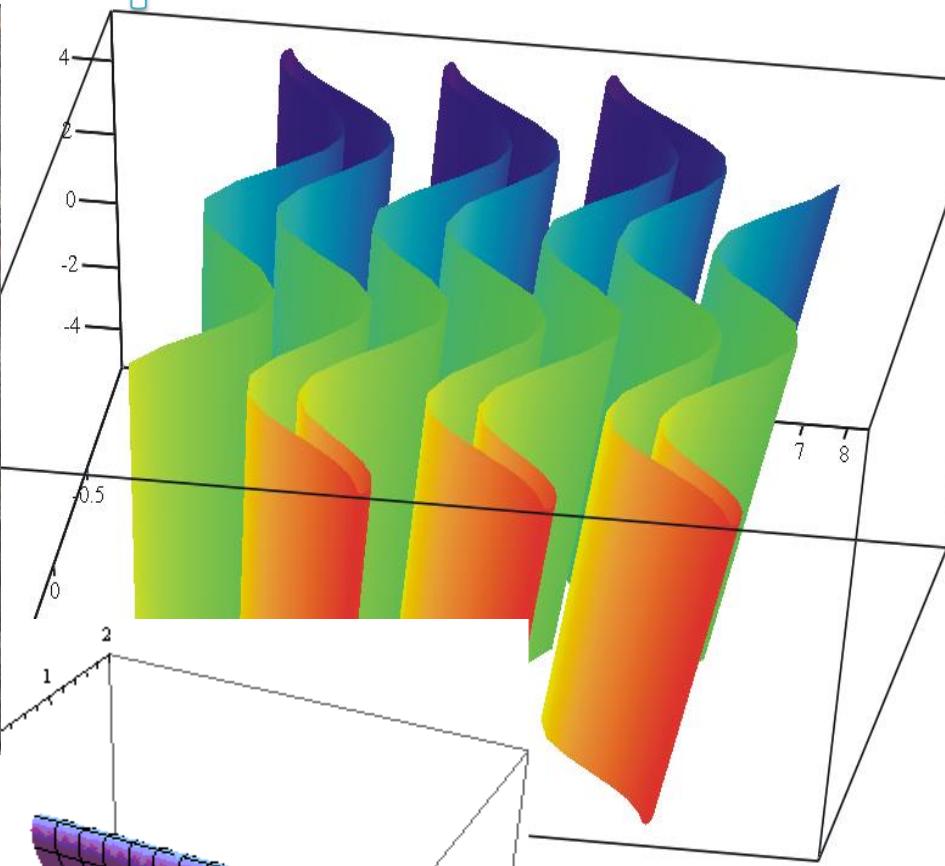
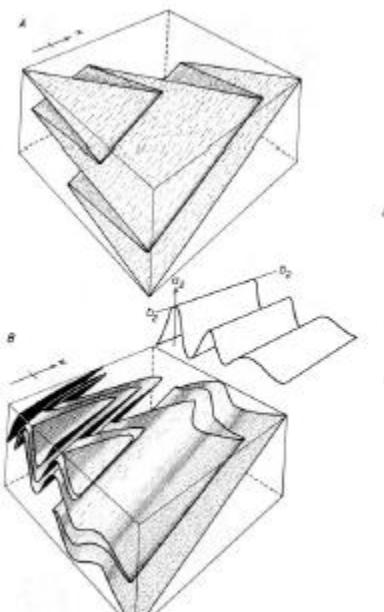
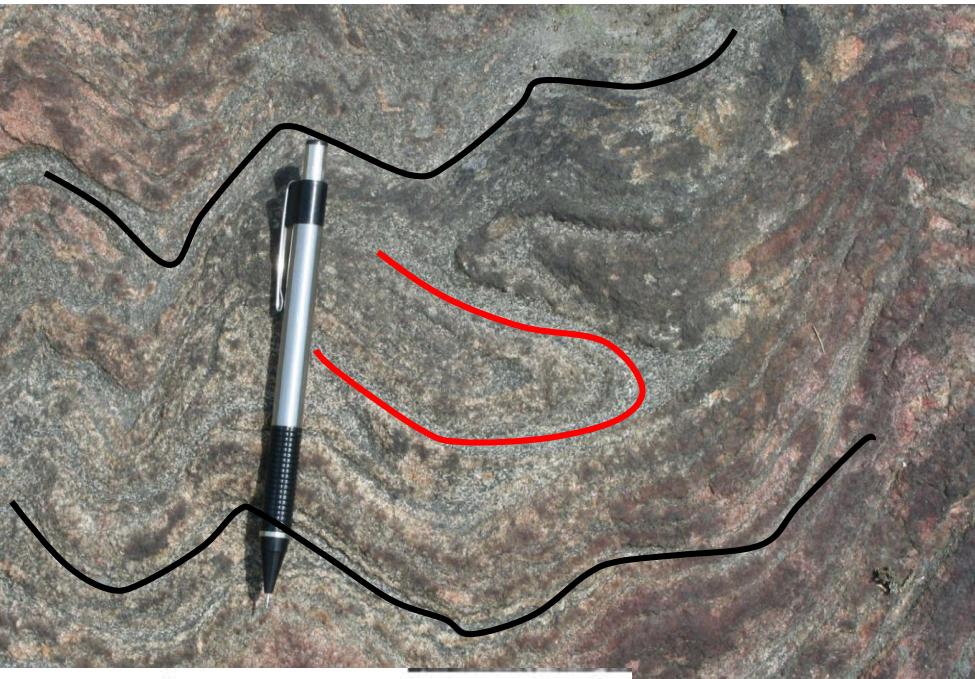


Jiang and Williams (1999)

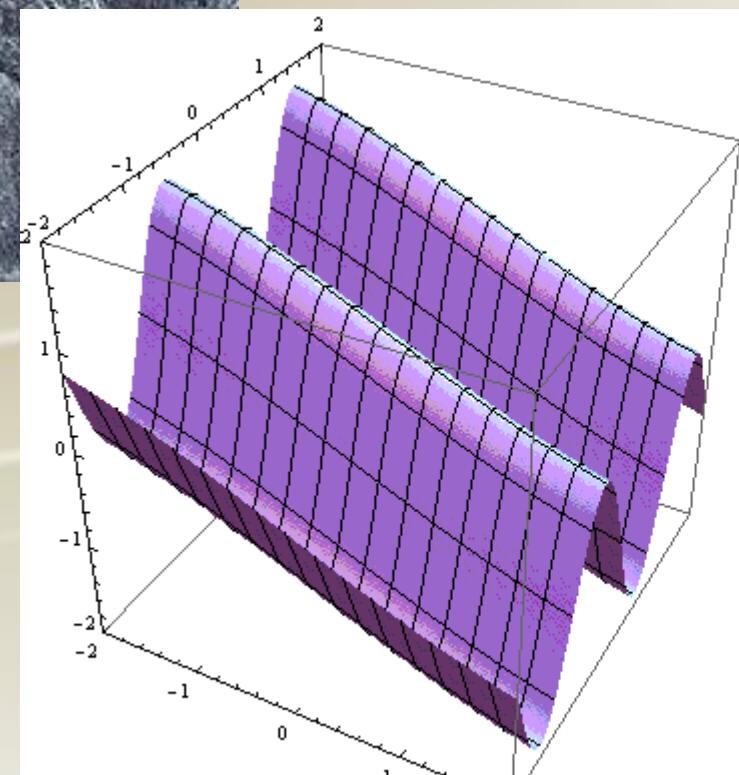
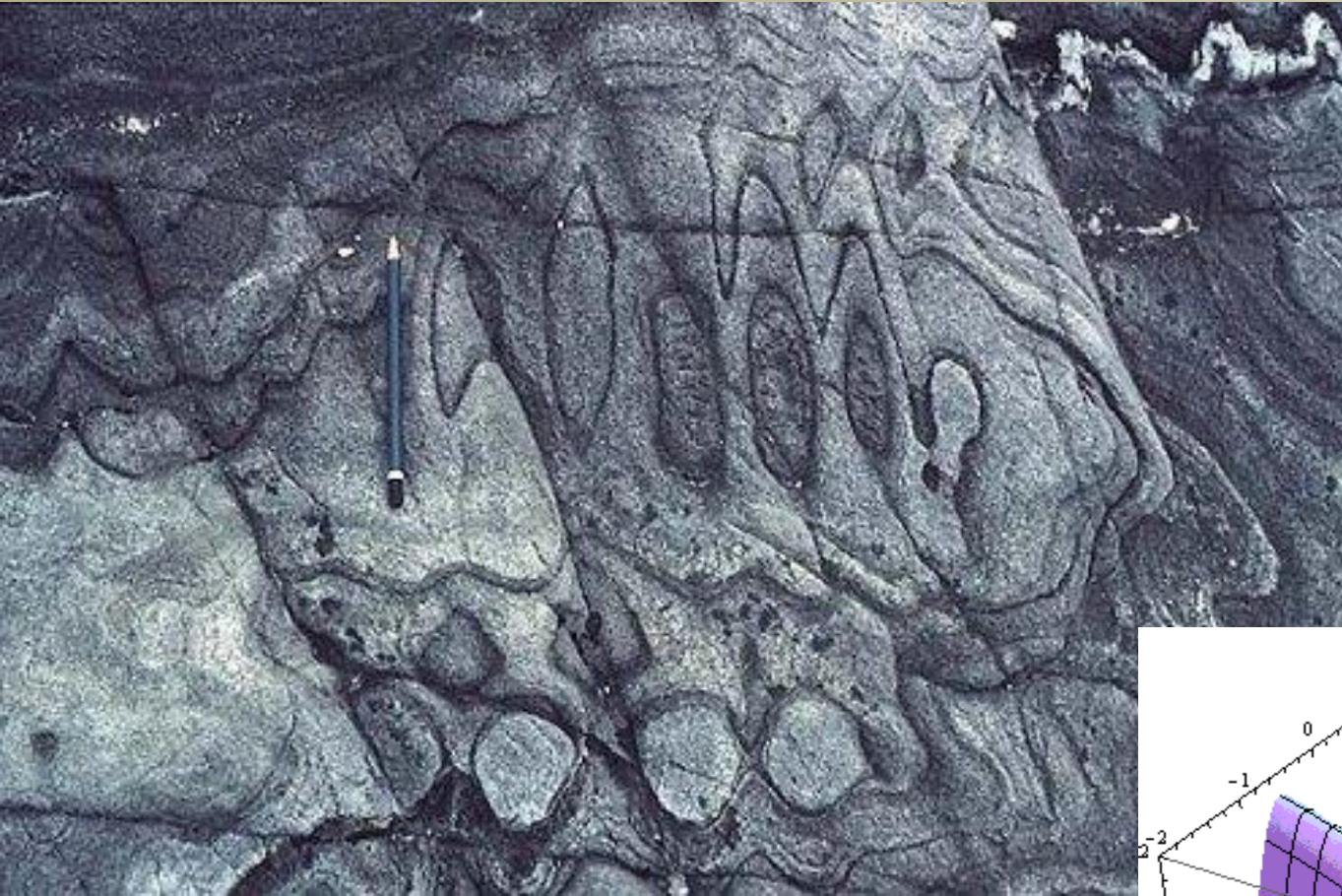




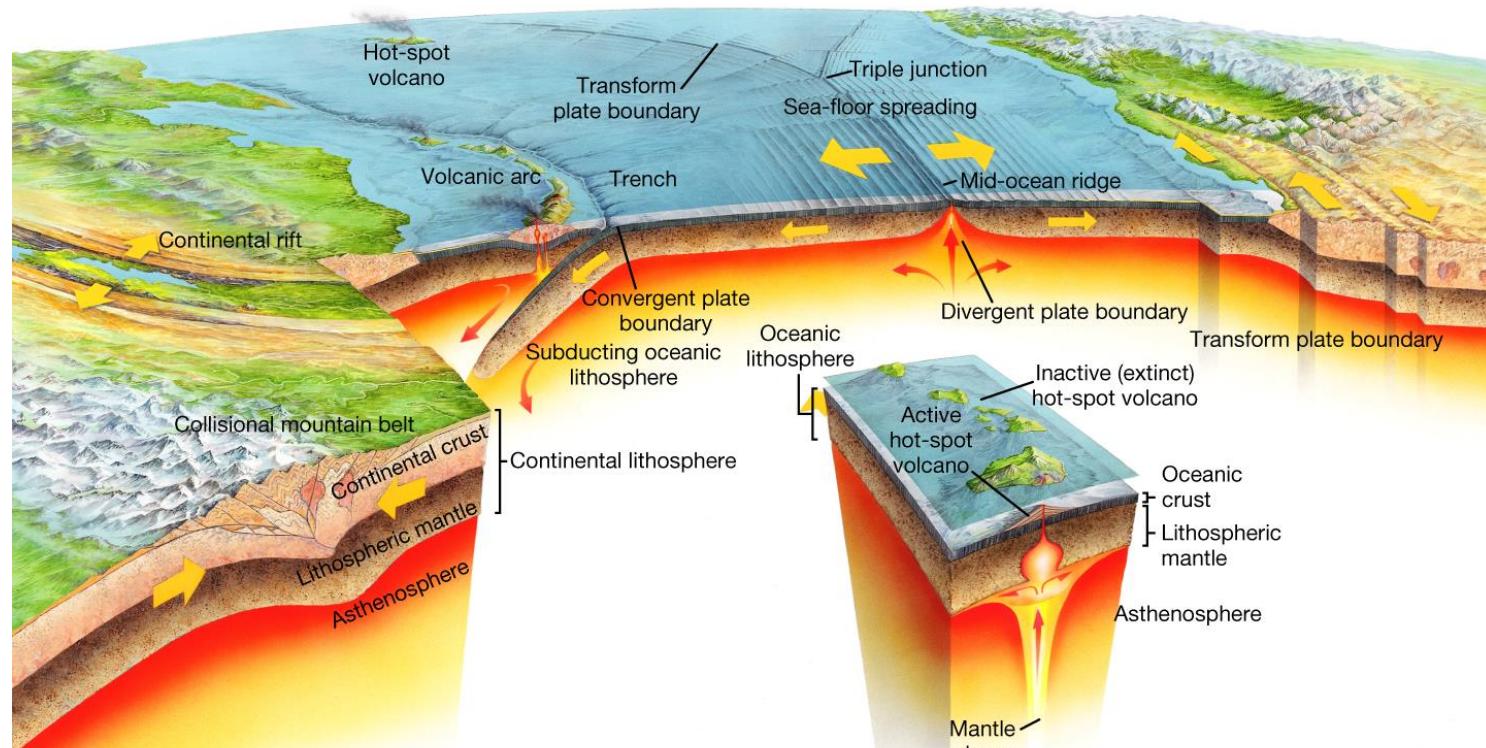
Deformation process



Overprinting relationship: Deformation sequences



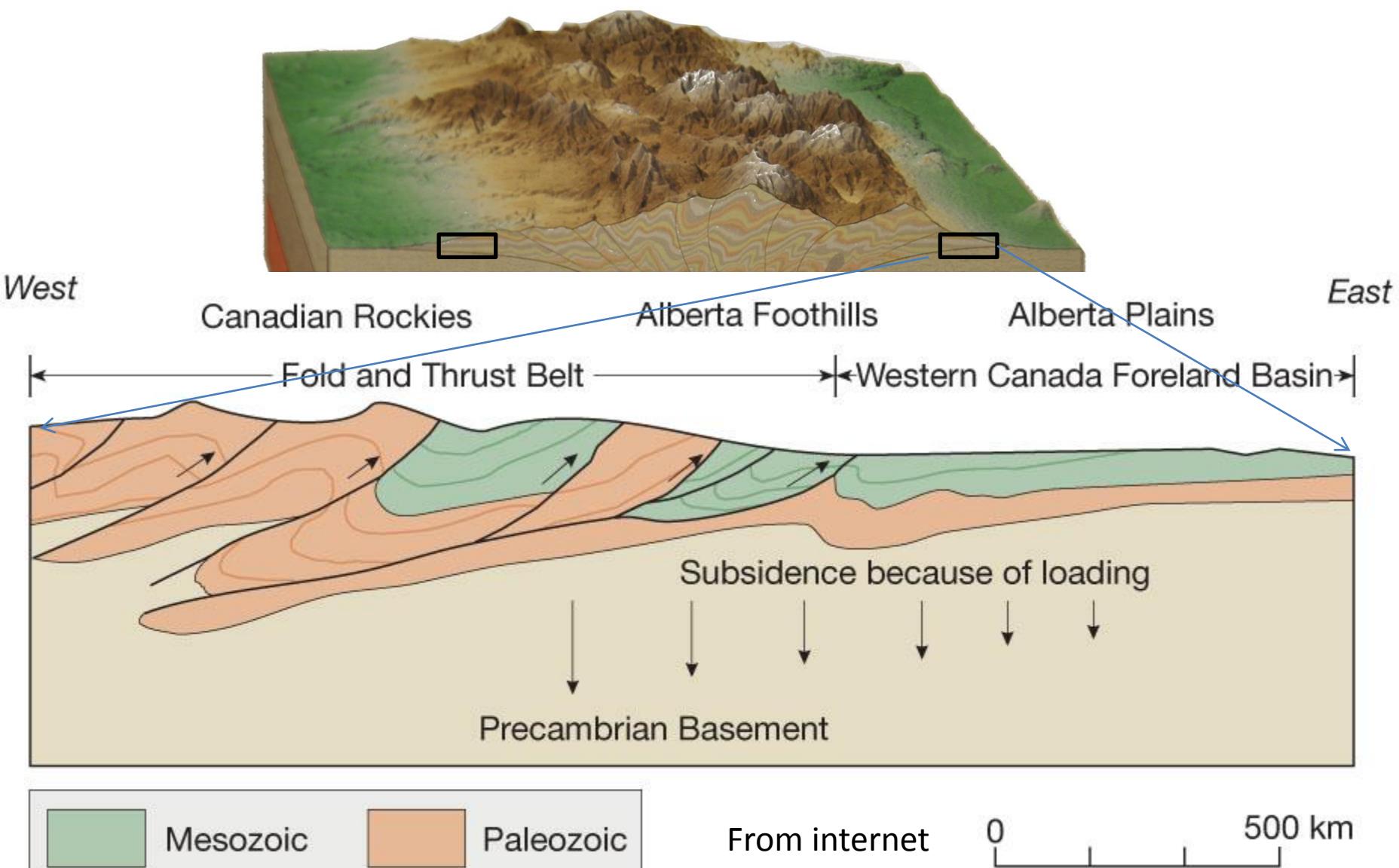
Deformation structures: fingerprint of plate tectonic movement



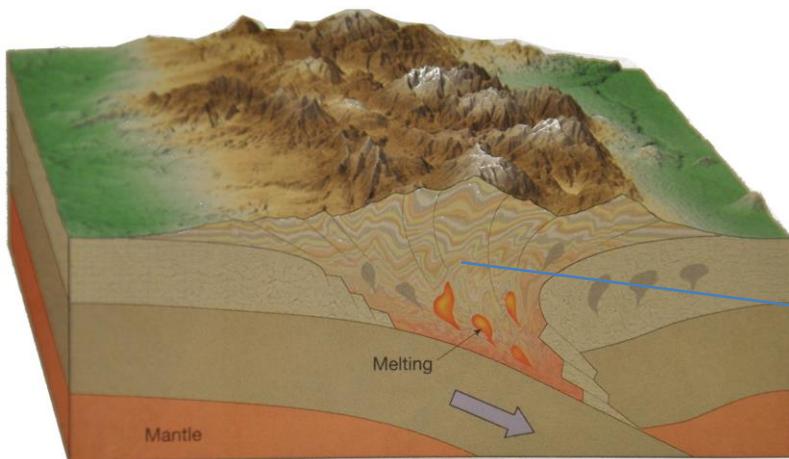
The Theory of Plate Tectonics

Plate tectonics causes plate boundaries and interiors to deform to produce structures [fingerprint of deformation]

Different tectonic deformation associated with different structures



Different tectonic deformation associated with different structures



Nappe

Parallel limbs

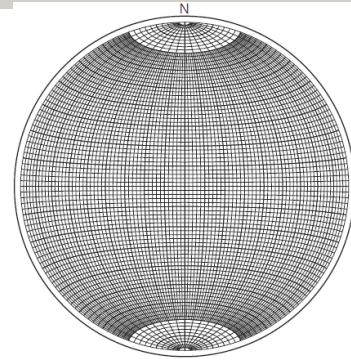
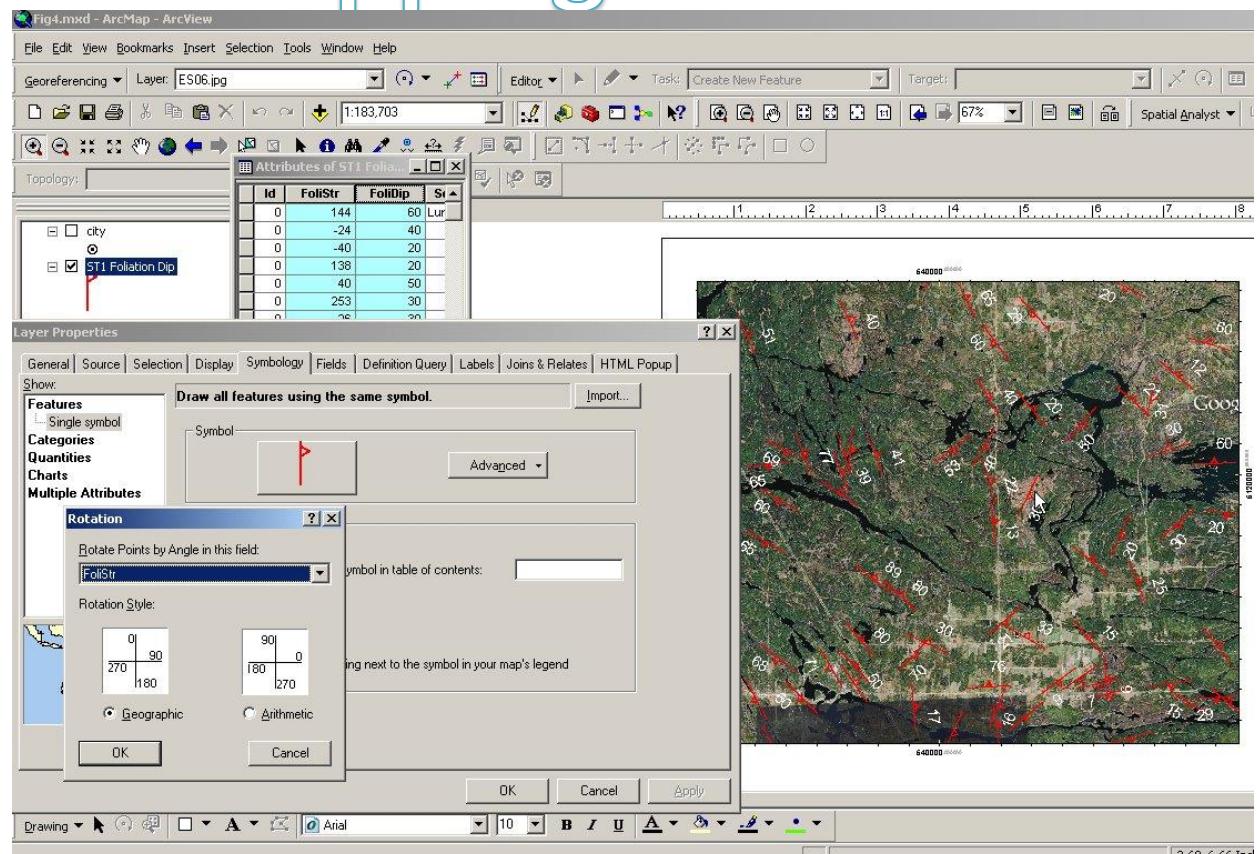
Geometrical study: most important



Sheep Mountain in the U.S.

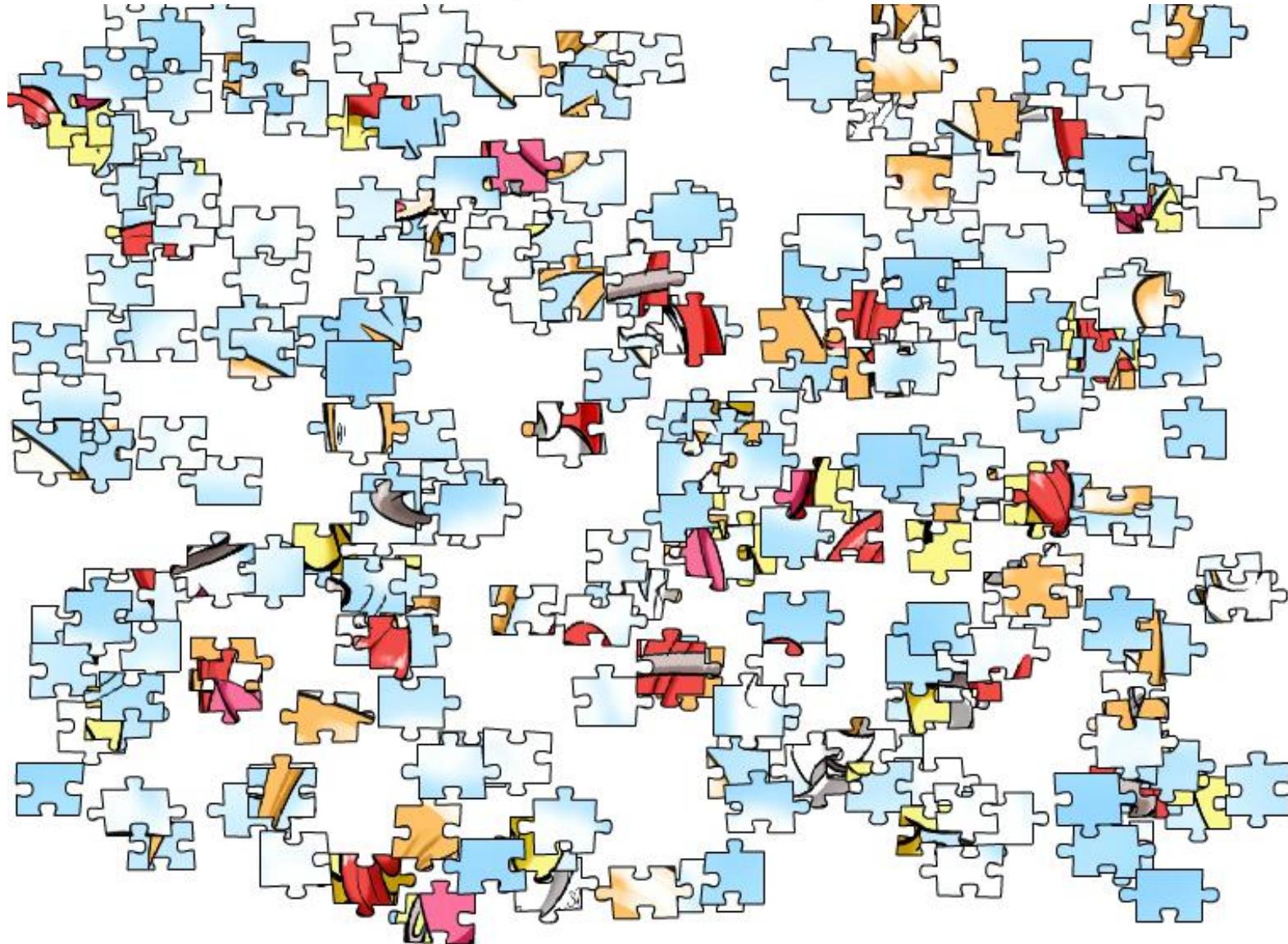


Mapping



Incomplete jigsaw puzzle

Mapping is interpretation









Field observation at outcrops

- Orientation
- Overprinting
- Distribution



Geometry In 3D for whole area:

- Orientation
- Overprinting
- Distribution



- History?
- Tectonic evolution?

- Numerical modeling

Two questions to think about

Q#1: What are the linear structures?



20km

Q#2

Q#2: How many generations of folds can you recognize? What's the overprinting relationship?

